

## METHOD AND APPARATUS FOR MANUFACTURING A CYLINDRICAL CONTAINER

### Background of the Invention

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#### 1. Field of Invention

This invention pertains to an improved method of producing a cylindrical container, and more particularly to utilizing a drawing and ironing process to make the container.

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#### 2. Description of the Related Art

Conventional pressure vessels, such as those used in the filter industry, are typically "drawn" vessels or containers. Drawing is a known metal fabrication technique wherein a given blank of material, particularly metal as used in pressure vessels, is reformed or reshaped to a particular, desired configuration. Drawing effectively retains or maintains the virgin, or original, material thickness throughout the walls of the vessel. Any reduction or thickening of material occurs by accident, or within the basic tolerance of established drawing techniques, which effect a maximum reduction of less than ten percent of the material thickness, more typically in the range of five to six percent.

Variation in material thickness may also occur due to clearances within the dies employed in the drawing process. In some cases, die clearances are designed to create localized stretching in the material. Stretching, during a drawing operation, does not, however, impart any improved or advantageous properties to the stretched portion of the drawn metal product.

Nevertheless, drawing is an established and extensively used technique for the formation of pressure vessels, since it does permit formation of a pressure vessel of, typically, cylindrical configuration and having a closed end, without the use of seams.

For example, earlier techniques would employ a flat sheet rolled into a container, requiring the formation of a side seam, with the further addition of an end piece suitably

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seamed to the open end of the cylindrical structure. Drawing thus eliminates the side seam and the end seam of such earlier prior art pressure vessels. While affording these advantages, drawing imposes limitations as discussed above, and moreover fails to provide the capability of precisely sizing the vessel, not only as to its principal

5 dimensions and particular diameter, but also, and to some extent more critically, as to the cross-sectional thickness of the walls of the metal vessel; in drawing operations, the latter is solely dependent upon the original or virgin material thickness. In view of the inability of drawing processes to size or control the material cross-sectional thickness, it is necessary, in the fabrication of drawn pressure vessels, to select a virgin material having  
10 a minimum thickness in light of its thickness tolerance, which is of sufficient strength to meet the maximum requirements of a pressure vessel, and to employ that same thickness throughout the entire vessel structure.

There is known in the art a fabrication technique termed "ironing," whereby metal  
15 is physically thinned by surface extension. U.S. Pat. No. 3,733,881 issued May 22, 1973 to Donald C. Grigorenko discloses a method and apparatus for making deep drawn and ironed metal shells wherein a metal disc is subjected to both drawing and ironing operations. In the particular process disclosed in that patent, a flat metal blank of virgin material is subjected to a reverse draw operation whereby the blank is shaped into a cup,  
20 or shell, of a first diameter and then is redrawn in an opposite direction to form a narrower diameter cup, or shell, of elongated axial length. The elongated shell is then subjected to successive ironing stages to reduce the side-wall thickness and thus elongate the axial dimension of the shell. The ironing technique is known to improve the physical characteristics of the ironed material in the side-walls. The conventional drawing and  
25 ironing process, however, has been used heretofore primarily for realizing material reduction, i.e., reducing the amount of material required to form a vessel of a given size, along with the elimination of the side and end seams as heretofore achieved by drawing operations alone.

30 The present invention comprises an improved cylindrical container having selectively controlled wall thicknesses, so as to provide the appropriate material thickness

in those portions of the vessel, as required for necessary "pressure" performance, yet having ironed side-walls which are of reduced thickness throughout a substantial portion of the axial extent of the cylinder.

5       Typically, to form a cylindrical vessel, a disc of the virgin metal is cut. The disc is then drawn into a cup-shape, which preferably may be accomplished by the reverse drawing operation disclosed in the above cited U.S. Pat. No. 3,733,881. The resultant, drawn, elongated shell is then subjected to one or more stages of ironing, performed by a specially configured mandrel which advances the drawn, elongated shell through one or  
10      more stages of ironing rings. The mandrel may be employed as well in the final drawing stage of a reverse draw operation as disclosed in the Grigorenko patent, or instead, may be used solely for the ironing operation.

15      In addition to the structural advantages and reduction in material and weight of the improved cylinder of the invention, additional advantages are also realized. The cylinder material is precisely sized throughout the side-wall portion, affording a cylinder that is made to an exact, repeatable standard. By utilizing drawing and ironing techniques, such as those disclosed in the Grigorenko patent, the drawn and ironed shell can be produced in a single stroke operation of appropriate equipment, the drawn and ironed shell being  
20      ready for trimming. The sizing achieved by the ironing process also permits the virgin material employed to be of much less critical tolerance, thus increasing the availability (i.e., source and acceptable tolerance) of the purchased raw, or virgin, material to be used. Since less material is employed, smaller initial discs are used as compared with conventional drawing operations, permitting better layouts in stamping the discs from  
25      sheets of virgin material and thus improving the yield of useable discs from a given sheet of material.

## Summary of the Invention

5 In accordance with one aspect of the present invention, a process for manufacturing a cylindrical container includes the steps of drawing and ironing, using a press, at least two metal shells, forming a container using the at least two metal shells, and attaching a valve portion to the container via a brazing process.

10 In accordance with another aspect of the present invention, the container has a sidewall, the sidewall having a thickness, the process further including the step of specifying the thickness of the sidewall to withstand hydrostatic pressure.

- 15 • In accordance with another aspect of the present invention, the process further includes the step of maintaining a substantially consistent thickness via a substantially uniform clearance between a punch and ironing ring.

In accordance with another aspect of the present invention, drawing and ironing, using a press, at least two metal shells further includes the step of drawing and ironing, using a hydraulic press, at least two metal shells.

20 In accordance with another aspect of the present invention, drawing and ironing, using a press, at least two metal shells further includes the step of drawing and ironing, using a mechanical press, at least two metal shells

25 In accordance with another aspect of the present invention, the method further includes the step of attaching a base to the container.

In accordance with another aspect of the present invention, the process further includes the step of increasing the thickness with each run through of the process.

Still other benefits and advantages of the invention will become apparent to those skilled in the art to which it pertains upon a reading and understanding of the following detailed specification.

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**Brief Description of the Drawings**

The invention may take physical form in certain parts and arrangement of parts, at least one embodiment of which will be described in detail in this specification and 10 illustrated in the accompanying drawings which form a part hereof and herein:

FIGURE 1 is a top view of the inventive container;

FIGURE 2 is a perspective view of the container;

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FIGURE 3 is a top view of the prior art container;

FIGURE 4 is a perspective view of the prior art container;

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FIGURE 5 is an exploded view of Section A of FIGURE 6;

FIGURE 6 is a view of the inventive container in an ironing die;

FIGURE 7 is a top view of another prior art container; and,

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FIGURE 8 is a perspective view of the prior art container shown in FIGURE 7.

**Description of the Invention**

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Referring now to the drawings wherein the showings are for purposes of illustrating at least one embodiment of the invention only and not for purposes of limiting

the same, FIGURES 1 and 2 illustrate the inventive container 10, which includes a valve portion 12, a valve 18, a body 14, and a base 16. FIGURES 3, 4, 7, and 8 show the prior art container 20, which has a top piece 26, a bottom piece 24, a base 36, a scuff protector 22, and flanges 28. The flanges 28 are attached to the top piece 26 and aid in the attachment of the top and bottom pieces 26, 24. The structure and operation of a cylindrical container are well known in the art, and for the sake of brevity, will not be further discussed herein. Utilizing the drawing and ironing process described above, two half shells (not shown) are joined together to form the container 10. A brazed, or similarly attached, valve portion 12 is attached to the container 10. The container 10 is trimmed with a spin trimmer (a spin trimmer is a rotary trimmer used to trim the ends of tubular or cylindrical parts). The base 16 is connected to the bottom of the container 10. This inventive process allows the sidewalls of the body 14 to be thinner. This process also eliminates at least one part and at least one assembly point, and can be used on any tubular part. In this particular embodiment, the base 16 is between approximately 0.045 inch and approximately 0.055 inch. This thicker base 16 enables the present invention to eliminate the need for an additional part to protect against scuffing the base 16. Since the additional part is eliminated, the manufacture and assembly process is made quicker, more efficient, and less expensive.

20        The inventive process, which utilizes a clearance between the punch and the ironing ring, enables the correct size for the container 10 every time. The brazing process helps relieve stress on the part. The brazing process is typically performed in either a batch, or conveyor type, furnace. Brazing, unlike welding, does not melt the parts together. Brazing is similar to soldering, except at a much higher temperature. Brazing 25 uses brass or copper with a flux material for cleaning and flow. The result is that brazing is a much stronger joint than soldering. In general, the higher the melt temperature of the medium, the stronger the joint. In this particular embodiment, the elimination of the scuff protector 22 means one less part to manufacture and assemble, which would help realize a cost advantage without reducing any performance characteristics.

With reference now to FIGURES 5 and 6, part of the ironing process is shown.

FIGURE 5 is an exploded view of Section A of FIGURE 6. FIGURES 5 and 6 show the container 10, the base 16, an ironing ring 30, original material thickness 32, gap 38, and sidewall thickness 34. The gap 38 between the ironing ring 30 and the container 10

5 controls the thickness of the sidewall 34. This control aids in the container performance. If the ring 30 begins to wear, the container 10 will be too short and will cause a failure to produce the desired length. Conversely, if the gap 38 is too small, the container will be too long, which will also cause a failure. Therefore, the use of the drawing and ironing process enables a more accurately produced part. The ironing process changes the grain 10 structure (cold flow or forming), increasing the hardness (mechanically) that allows the process to perform effectively in this particular embodiment.

It is to be understood that this invention can be used on any cylindrical container, as long as chosen sound engineering judgment. For example, the present invention is 15 applicable to fire extinguishers, medical grade Freon containers, and other pressurized and non-pressurized cylinders. The previous list is not intended to be limiting or all-encompassing of the examples of the invention.

The invention has been described with reference to at least one embodiment.

20 Obviously, modifications and alterations will occur to others upon a reading and understanding of this specification. It is intended to include all such modifications and alterations in so far as they come within the scope of the appended claims or the equivalence thereof.

25 Having thus described the invention, it is now claimed: